The Effect Of Participation In A Stone Laboratory Workshop (A Place-Based Environmental Education Program) On Student Affect Toward Science

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Abstract. This case study measures how participation in a one-and-one-half-day place-based environmental education program (the F.T. Stone Laboratory student workshop) influences the affect component of attitudes (otherwise defined as "feelings") toward science among sixth grade students. Prior to and following a Stone Laboratory workshop, students were surveyed regarding how they felt about science. Across the entire sample (n=90) there was a small but consistent positive change in student response on the written survey, suggesting that participation in the Stone Lab workshop has a positive influence on general affect toward science in the short-term. Analysis by defined subscales was also conducted, highlighting significant positive change for students on the General Science Feelings and Value of Science subscales. The effect is strongest among male participants in this group.

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INTRODUCTION

One of the key goals of environmental education, as defined by the North American Association for Environmental Education (NAAEE), is to help learners develop the skills they need to be effective and knowledgeable decision makers (Braus and Wood 1993; NAAEE 1998). An important characteristic that influences an individual's ability to make decisions is attitude regarding the issue of concern. Specifically, an individual's attitude dictates his/her motivation to participate in the decision making process (Sanbonmatsu and Fazio 1990). Furthermore, research has suggested that people use their feelings to guide them in making decisions (Finucane and others 2000). Taking these studies into account, one can postulate that how a student feels about science could have a significant impact on the future decisions s/he will make in that arena. A review of recent studies has indicated an overall decrease in interest in science among students, as well as in the general public (Osborne and others 2003). This would indicate a need for programs that are designed to help mitigate this trend. Furthermore, Osborne and others (2003) specifically note in their discussion the "enduring" quality of attitudes and how negative attitudes could cause even more students to turn away from scientific fields and science in general. Given such concerns, our study aims to investigate the impact that an outdoor place-based environmental education program has on how students feel about science.

There is a general consensus in attitude research that, while attitude is difficult to define specifically, it has three important connecting components: affect (feelings), conation (behavior) and cognition (knowledge) (Azjen and Fishbein 1980; Shrigley and others 1988). Research treats these three personal attributes as integral to the development of a particular individual's attitude toward an issue or object. The exact role each component plays in determining an individual's overall attitude and resulting prediction of behavior may differ by situation, but affect has been regarded as the component with the greatest influence on attitude development (Eagly and Chaiken 1995).

Previous studies of place-based and environmental education programs indicate the programs have varied in their effectiveness in changing learners' attitudes about science-related topics. Some have shown a positive influence on student attitudes toward science (Dettman-Easler and Pease 1999; Kruse and Card 2004; Farmer and others 2007), whereas others have shown no effect, or even a negative effect (Crompton and Sellar 1981; Eagles and Demare 1999). Numerous reasons have been cited for these varying levels of effect, such as the qualities of the environment where the program takes place and whether the programs were accompanied by reinforcement within the classroom (Dettman-Easler and Pease 1999). Other studies have shown that demographics can play a role in determining the attitudes students have toward science (Haladyna and others 1982; Kellert 1985; Atwater and others 1995; Eagles and Demare 1999; Barmby and others 2008). Thus a consensus has yet to emerge regarding the key factors that determine whether a program facilitates a positive attitudinal change toward science.

This study investigates the degree to which a specific place-based, participatory, field environmental education program is effective in changing students' affect (or feelings) toward science. It is a case study focused on northern Ohio sixth graders participating in an outdoor science program at The Ohio State University's F.T. Stone Laboratory (hereafter, Stone Lab), located in Put-in-Bay, OH. Stone Lab activities focus on participatory science learning and place-based education. Place-based education is defined as learning that is highly dependent upon the location where the learning takes place - the curriculum tends to be multidisciplinary and experience based and "connects place with self and community" (Sanger 1997; Woodhouse and Knapp 2000; Semken and Freeman 2008). Participatory science learning complements place-based education well because it enables students to develop a personal ownership over the process of completing the educational activity as well as derive meaning from the science that they practice (Fenwick 2000; Barab and Hay 2001). Both of these modes of learning, addressed by Stone Lab practice, provide students with an opportunity to personalize and reflect on their learning experience in a different manner than in a typical classroom.

This study was designed to focus on the feelings that students have toward science and whether a program such as Stone Lab's can influence these feelings. Pre- and post-program surveys were designed, implemented and analyzed to address the following research question for a sample of sixth grade students in a one-and-one-half-day program:

To what extent does participation in a Stone Laboratory workshop influence (in the short-term) the affect component of attitude toward science?

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MATERIALS AND METHODS

Setting

F.T. Stone Laboratory, part of the Ohio Sea Grant College Program, offers programs for a wide variety of age groups and grade levels, including programs for students in elementary through high school, college courses, and teacher education. The program examined here was the sixth grade program, which generally lasts between one half and two days (the specific workshop for the study sample lasted one-and-one-half days). These programs include activities and instruction covering topics such as ornithology, exotic species, invertebrates, edible plants, water quality, seining, and fish dissections, as well as many other science-based experiences. Students were also afforded the opportunity to participate in water sampling and other activities on a research vessel.

Data Collection

Data collection consisted of paper/pencil surveys for subjects immediately prior to and following student participation in the workshop. The same surveying technique was followed for each of the groups, with their classroom instructors administering the instrument. The teacher who administered the surveys assigned a confidential number to each student to prevent researchers from connecting specific students to their responses, as well as to facilitate matching pre-visit survey data to the post-visit survey.

Instrumentation and Analysis

The pre- and post-test survey was adapted from the Attitude Toward Science in School Assessment (ATSSA) (Germann 1988). A Likert-type scale was used to identify the degree of strength of the students' attitudes on each statement within the instrument with five representing the most positive feelings and one being the least positive feelings. Initial tests of the ATSSA instrument showed it to have a high degree of both reliability and validity in measuring attitudes, with a Cronbach's alpha level ≥0.95 (Germann 1988). Supplementary statements were drawn from another reliable and valid science attitude instrument, the Science Attitude Inventory (SAI) (Moore and Sutman 1970; Moore and Foy 1997) in order to capture additional information. The survey questions were divided into subscales (Fig. 1). Reliabilities of subscales ranged from 0.93 to 0.67 (Table 1).

Survey data were analyzed using paired samples t-tests. Demographic characteristics (e.g. gender and expressed interest in science) were used as independent variables for comparing student responses regarding their feelings about science. In addition to items on the ATSSA survey, students were also asked their preferences for favorite and least favorite subject as another method of assessing student attitudes toward science.

Subjects

Short-term effects of the Stone Laboratory program were tested among the sixth grade (usually 10 - 12 years old) participants from a northern Ohio school district. Seven groups of approximately 40 sixth grade students each participated in the Stone Lab workshop over a period of a week and a half, with each group on site at the Lab for one and one-half days. This population is ideally suited to answering the key research question because the school district sends <u>all</u> sixth graders to Stone Lab, rather than selectively sending only the advanced or "gifted" students as is done in many other districts. Because of this practice, it was possible to examine Stone Lab's influence on affect toward science for students with a wide range of interests and ability levels.

Treatment

At Stone Lab, students participated in a variety of hands-on activities including lessons such as a science cruise, plankton and fish labs, insect collecting and ornithology (bird walk) (Dress 2002). In classroom sessions at their school immediately prior to and following the Stone Lab experience, students learned how to identify organisms under a microscope and to identify fish. The school also infuses activities from the Oceanic Education Activities for Great Lakes Schools (OEAGLS) curriculum, which was produced by Ohio Sea Grant Education, in their sessions complementing the Stone Lab workshop. This supplemental curriculum was created as an integrated science activity set to help students develop their knowledge and awareness about oceanic and lake ecosystems (Mayer and Fortner 1993).

General Science Affect

- Science is fun.
- I have good feelings toward science.
- Most people can understand science.
- Science is interesting to me and I enjoy it.
- Science is fascinating and fun.
- I do not like science.
- I feel as ease with science and I like it very much.
- I feel a definite positive reaction to science.

The Value of Science

- It is important to understand science.
- Science is important.
- Science is useful.
- Everyone should understand science.
- Science is not really related to my life.

Science Class or In School

- It bothers me to study science.
- I would like to learn more about science.
- I would feel sad if I never had science class again.
- Studying science make me impatient.
- Science is a topic that I enjoy studying.
- Science is boring.
- During science class, I am usually interested.
- Science make me uncomfortable.
- It is hard for me to understand science.
- Science is hard.

Science as a Career

- I would like to be a scientist.
- I would enjoy studing science in the future.
- Working in a science lab would be fun.
- Scientists have exciting lives.
- Scientists don't contribute useful things to the world.

FIGURE 1. Subscales for survey instrument and the questions loaded on each.

RESULTS

General

Administration of the survey prior to and following the students' Stone Lab experience yielded a total of 90 completed pre- and post-test surveys from the sampled population. Since a census of all Stone Lab participants from the target school / grade was attempted (~280 students), the response rate was 32 percent. Human subjects protocol required students to return parental permission slips in order to participate in the study. The fact that this makes the sample essentially self-selecting is an unavoidable occurrence for these types of studies. Non-respondents cannot be followed-up because of the lack of parental permission. Therefore, this factor should be taken into consideration in interpreting the results.

The first analysis was an overall paired samples t-test (α =0.05, t=2) on students' responses for the instrument as a whole (Table 2). Mean response on the pre-test was 3.58 (on five point scale); the mean response on the post-test increased to 3.67. Overall, this was a significant positive change in students' feelings toward science for the entire instrument (α=0.017).

Data analysis using subscales allowed for a clearer picture of which categories of student feelings showed the greatest amount of change. Paired samples t-tests were conducted on the pre- and post-test values of these subscales for all subjects (Table 3). The General Science Feelings (GSF) and Value of Science (VS) subscales showed a significant positive change in student affect between tests for items included on them. Although not significant, a positive increase in students' mean responses was found on each of the other subscales as well.

By demographics

Student affect varied between gender groups. For data split by gender, on the instrument as a whole, paired samples t-tests using α=0.05 and tabled t=2 showed significant change for males (n=36) but not for females (n=51) (Table 2). This was further evident when the data were broken down by subscales (Table 4). In fact, males showed significant change with a 95 percent confidence level in two subscales (GSF and VS), whereas females did not show significant change in any of the four subscales (Table 4). Using α=0.10, males also had significant positive change for the Science Class or In School (SCL) and Science as a Career (SCR) subscales. In addition, pre-test means were higher for males than for females across all subscales. For the two subscales where males showed significant change at α=0.10 (SCL and SCR), means for females actually decreased slightly between pre- and post-test. These were also the same subscales where there was the largest overall difference between male and female responses. All pre-test means for both genders were over 3.0 (3 = neutral) suggesting that most students started out with slightly positive affect toward science (Table 4). Subsamples representing ethnicities of the students were too small for reliable analysis.

By favorite subject in school

In addition to the t-test analyses of survey data, descriptive analyses of student reports of favorite and least favorite subjects were also performed (Table 5). The results are frequencies of responses. While they do not indicate a significant change in student feelings, more students listed science as their favorite subject following their Stone Lab experience than prior to it. Accordingly, fewer students listed science as their least favorite subject on the post-test compared to the pre-test.

DISCUSSION AND RECOMMENDATIONS

Discussion of Findings

Key Research Question: To what extent does participation in a Stone Laboratory workshop influence the affect component of attitude toward science?

Table 1

Reliability coefficients (Crobach's α) for each of the measured subscales between pre- and post-test measures.

Subscales		Reliability	Variance
General Science Affect			
	Pre-test	0.8932	0.0546
	Post-test	0.9255	0.0283
Science Class or In School			
	Pre-test	0.8824	0.0192
	Post-test	0.9273	0.0348
The Value of Science			
	Pre-test	0.7116	0.0151
	Post-test	0.6668	0.0135
Science as a Career			
	Pre-test	0.7784	0.0296
	Post-test	0.7684	0.0592

Table 2

Paired t-test values for analysis of resonses (n=89) to overall instrument. Data are presented for all subjects and also by gender.

	Pre-test Mean	Post-test Mean	Mean Diff.	Stand. Error	T-value	df	Signifi-cance
All Subjects	3.5842	3.6703	0.0862	0.0353	2.442	89	0.017*
Male	3.7210	3.8885	0.1675	0.0638	2.625	35	0.013*
Female	3.5053	3.5342	0.0289	0.0408	0.709	50	0.482

*Significant at α = 0.05

Table 3

Means and paird t-test values for analysis of responses in each subscale for all subjects (df = 89)

	Pre-test Mean	Post-test Mean	Mean (diff.)	Stand. Error	T-value	Signifi-cance
Gen. Science Feelings	3.5825	3.7371	0.1546	0.0507	3.049	0.003*
Science in Class	3.4991	3.5677	0.0686	0.049	1.401	0.165
Science as a Career	3.4033	3.4431	0.0398	0.0543	0.817	0.416
Value of Science	3.7107	3.8372	0.1265	0.0488	2.329	0.022*

* Significant at α = 0.05

Although students started out slightly positive in their feelings toward science, they became more positive following their participation at Stone Lab (Table 2). This was a change significant at a 95 percent confidence level. Although, practically speaking, the change is very small, the fact that it is a significant change indicates that the Stone Lab experience has a positive influence on students' feelings.

The authors acknowledge an additional factor that could have influenced results; that is the poor weather experienced during the workshop for this school district. Weather variations often are a downside of one-shot place-based education. Because of inclement weather, students did not experience the full potential of a Stone Lab workshop. In stormy weather, for example, the research vessel must stay in shallower water. This keeps the students from completing all the activities they would normally do in deeper waters (e.g. fish trawl and dissolved oxygen and temperature variations with depth).

Nevertheless, results from subscale analysis also showed significant positive change for all students on General Science Feelings (GSF) and the Value of Science (VS) with a confidence level of 95 percent. Though the high pre-test values show students already had a positive view of the importance of science and positive feelings about science in general, participating in the Stone Lab workshop still influenced these feelings even if only to a small degree (Table 3).

As for the other two subscales, Science in Class (SCL) and Science as a Career (SCR), student responses showed positive, though not significant, change. It is possible that these two subscales are more easily influenced by other outside experiences than perhaps GSF or VS would be. Intervening variables, such as students thinking about their traditional science courses in school, might affect these measures. Furthermore, some students may simply not plan to pursue a career in the science field regardless of their feelings toward the subject itself, an artifact of soliciting responses from all students in the sixth grade rather than sampling those in a more select science-oriented group of visiting students.

Analysis based on gender groups showed that male students in the current study had significant change on the instrument as a whole and on all of the subscales whereas females showed no significant change for any of the analyzed units (Tables 2 and 3). Given that all students participated in the same activities in the same setting, we postulate that the gender of each student's instructor could be a factor here. Current research by Dee (2007) has indicated that the gender of an instructor can impact the engagement and success of the student. While Stone Lab instructors, for the sample, included both male and female instructors, there are no data available for which students were with each instructor. It would be interesting to see if the level of change in feelings about science for females is different depending upon the whether they had a male or female instructor. Studies have shown conflicting results when looking at the impact of same gender instructors for students. While the Dee (2007) study showed an effect on students due to teacher gender, other studies have shown gender to have no effect on students (Holmlund and Sund, 2008; Marsh and others, 2008). In addition, many of these studies focus more on achievement than specific measure of affect or other dimensions of attitude. It would be beneficial to explore this aspect of influence on the students further. It is, of course, possible that other outside societal influences may also be a significant factor.

On the survey instrument, students were also asked to identify their favorite and least favorite subjects. A noteworthy result of these reports is that more students identified science as their favorite subject following their Stone Lab workshop than prior to it. Therefore, although these results are not significant, students did self-report that they liked science a little better after this experience.

The results suggest that participation in a Stone Lab workshop has a positive influence on how students feel about science in the short-term. Whether this statement can be extended to describe long-term benefits of participation is more ambiguous and would require further research than is reported here. Attempts to contact the sixth grade cohort in higher grades did not yield samples of sufficient size for analysis.

Recommendations for Future Research

While this study is another good example of how environmental education and place-based education can have positive influence on student affect, there is still much that needs to be done. In some areas, this study is contrary to what other researchers (e.g. Atwater and others, 1995) have identified in terms of outdoor programs' influence on student feelings and attitudes (especially between demographic groups). Therefore, additional studies about Stone Lab's impact on learners should be completed to further describe the influence that its workshop has on participants' attitudes and feelings toward science. This would also add to the sample size

Table 4

Means and paired t-test values for analysis of responses by gender. Male df=35(N=36); Female df=50 (N=51).

	Pre-test Mean	Post-test Mean	Mean (diff.)	Stand. Error	T-value	Significance
General Science Feelings						
Male	3.7024	3.9668	0.2644	0.0764	3.460	0.001**
Female	3.5000	3.5742	0.0742	0.0693	1.071	0.289
Science in Class						
Male	3.6262	3.7976	0.1713	0.0940	1.822	0.077*
Female	3.4289	3.4231	-0.0058	0.0523	-0.111	0.912
Science as a Career						
Male	3.6236	3.7741	0.1505	0.0793	1.896	0.066*
Female	3.2755	3.2474	-0.0281	0.0636	-0.442	0.661
Value of Science						
Male	3.7972	3.9764	0.1792	0.0839	2.136	0.040**
Female	3.6641	3.7686	0.1046	0.0747	1.399	0.168

* Significant at $\alpha = 0.05$;
** Significant at $\alpha = 0.10$

Table 5

Frequency of student-reported favorite and least favorite subjects for pre- and post-test survey responses.

Subject	Science		Math		Other	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Favorite	30	34	26	25	30	26
	33.3%	37.8%	28.9%	27.8%	33.3%	28.9%
Least favorite	17	14	29	31	41	43
	18.9%	15.6%	32.2%	34.4%	45.6%	47.8%

numbers which would allow researchers to investigate trends across demographic groups. Specifically, additional research should also look at the demographic components of the educational program(s) (teacher gender and others) that may impact students' feelings toward science.

This research reported on the short-term impact of the Stone Lab program, but future research should also look at identifying long-term trends of attitude change at Stone Laboratory. While any positive change is good, long-term change would be most ideal for looking at student attitude impacts throughout their lives. It would be beneficial to follow one group of students over a number of years to see how their feelings about science and Stone Lab's influence on those feelings change over time. Time constraints prevented this study from doing so. Ideally a case study, such as this one, would be used as a starting point for determining whether Stone Lab workshops have a demonstrable long-term impact on students.

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